TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Polychlorinated Biphenyls (PCBs)

In

Woods Reservoir

Upper Elk River Watershed (HUC 06030003)

Coffee and Franklin Counties, Tennessee

FINAL

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LIST OF ABBREVIATIONS

ADB	Assessment Database
BCF	Bioconcentration Factor
BMP	Best Management Practices
CFR	Code of Federal Regulations
EFO	Environmental Field Office
GIS	Geographic Information System
HRT	Hydraulic Retention Time
HUC	Hydrologic Unit Code
LA	Load Allocation
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
NHD	National Hydrography Dataset
NPL	National Priorities List
NPS	Non-point Source
NPDES	National Pollutant Discharge Elimination System
PCB	Polychlorinated Biphenyl
PPM	Parts per Million
RM	River Mile
STP	Sewage Treatment Plant
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WLA	Waste Load Allocation
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

WOODS RESERVOIR (TN06030003036_1000)

Total Maximum Daily Load for Polychlorinated Biphenyls (PCBs) as Identified on the State of Tennessee's *2006 303(d) List*

Impaired Waterbody Information:

State: Tennessee
Counties: Coffee and Franklin
Watershed: Upper Elk River Watershed (HUC 06030003)
Constituent of Concern: Polychlorinated Biphenyls (PCBs)
Impaired Waterbodies: *2006 303(d) List*

Waterbody ID	Impaired Waterbody	Miles/Ac
TN06030003036_1000	Woods Reservoir	3908 ac

Designated Uses:	Domestic water supply, fish & aquatic life, industrial water supply, irrigation, livestock watering & wildlife, and recreation.
Applicable Water Quality Standard:	Most stringent numerical criteria applicable to recreation use classification.
Toxic Substances:	The waters shall not contain toxic substances, whether alone or in combination with other substances, that will render the waters unsafe or unsuitable for water contact activities including the capture and subsequent consumption of fish and shellfish, or will propose toxic conditions that will adversely affect man, animal, aquatic life, or wildlife. Human health criteria have been derived to protect the consumer from consumption of contaminated fish and water. The water and organisms criteria should only be applied to those waters classified for both recreation and domestic water.

TMDL Development

General Analysis Methodology:

- Composite fish tissue samples were collected and analyzed for PCBs. Existing loads of PCBs in the water column are estimated from the fish tissue concentrations using the Bioconcentration Factor defined by the U.S. Environmental Protection Agency.

- The maximum allowable PCB load is based on the product of the median winter pool volume and the water quality criterion established by the Tennessee Department of Environment and Conservation, Division of Water Pollution Control.

- The TMDL is established by dividing the maximum allowable load by the hydraulic retention time.

- Waste Load Allocations (WLAs) are derived for point source dischargers of PCBs.

- Load Allocations are established for non-point sources of PCBs using a mass-balance approach.

Critical Conditions: Methodology takes into account all flow conditions.

Seasonal Variation: Methodology addresses all seasons.

Margin of Safety (MOS): 20% (Explicit).

TMDL/Allocations

Waterbody ID	Impaired Waterbody	Pollutant	TMDL	WLA	LA	MOS	*Required Load Reduction**
			[g/day]	[g/day]	[g/day]	[g/day]	*[%]*
TN06030003036_1000	Woods Reservoir	PCBs	0.19	N/A	0.15	0.04	*93.6*

*Note: Load reduction required to achieve TMDL.

TOTAL MAXIMUM DAILY LOAD (TMDL) FOR PCBs WOODS RESERVOIR (TN06030003036_1000)

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology-based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Impaired waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those waterbodies that are not attaining water quality standards. State water quality standards consist of designated use(s) for individual waterbodies, appropriate numeric and narrative water quality criteria protective of the designated uses, and an antidegradation statement. The TMDL process establishes the maximum allowable loadings of pollutants for a waterbody that will allow the waterbody to maintain water quality standards. The TMDL may then be used to develop controls for reducing pollution from both point and non-point sources in order to restore and maintain the quality of water resources (USEPA, 1991).

2.0 WATERSHED DESCRIPTION

Woods Reservoir is located in Coffee and Franklin counties of southern Middle Tennessee. The reservoir runs along the Elk River, beginning around mile 170. The United States Air Force constructed the Elk River Dam in 1952 creating Woods Reservoir as a source of cooling water for processes at the Arnold Engineering Development Center. Woods Reservoir is located within the Upper Elk River Watershed (ref.: Figure 1).

The Upper Elk River Watershed, Hydrologic Unit Code (HUC) 06030003, includes parts of Bedford, Coffee, Franklin, Giles, Grundy, Lincoln, Marshall, and Moore counties in Tennessee. This watershed lies within two Level III ecoregions (Interior Plateau and Southwestern Appalachians) and contains four Level IV subecoregions (USEPA, 1997) as shown in Figure 2.

The Upper Elk River Watershed (HUC 06030003) has approximately 1,812 miles of streams and 14,504 reservoir/lake acres (based on the USEPA/TDEC Assessment Database (ADB)) and drains approximately 1,283 square miles into the Lower Elk River Watershed, eventually joining the Tennessee River. Land use distribution is based on the 1992 Multi-Resolution Land Characteristic (MRLC) satellite imagery databases. Table 1 summarizes land use for the Upper Elk River Watershed, which is shown in Figure 3.

Figure 1 Location of Upper Elk River Watershed

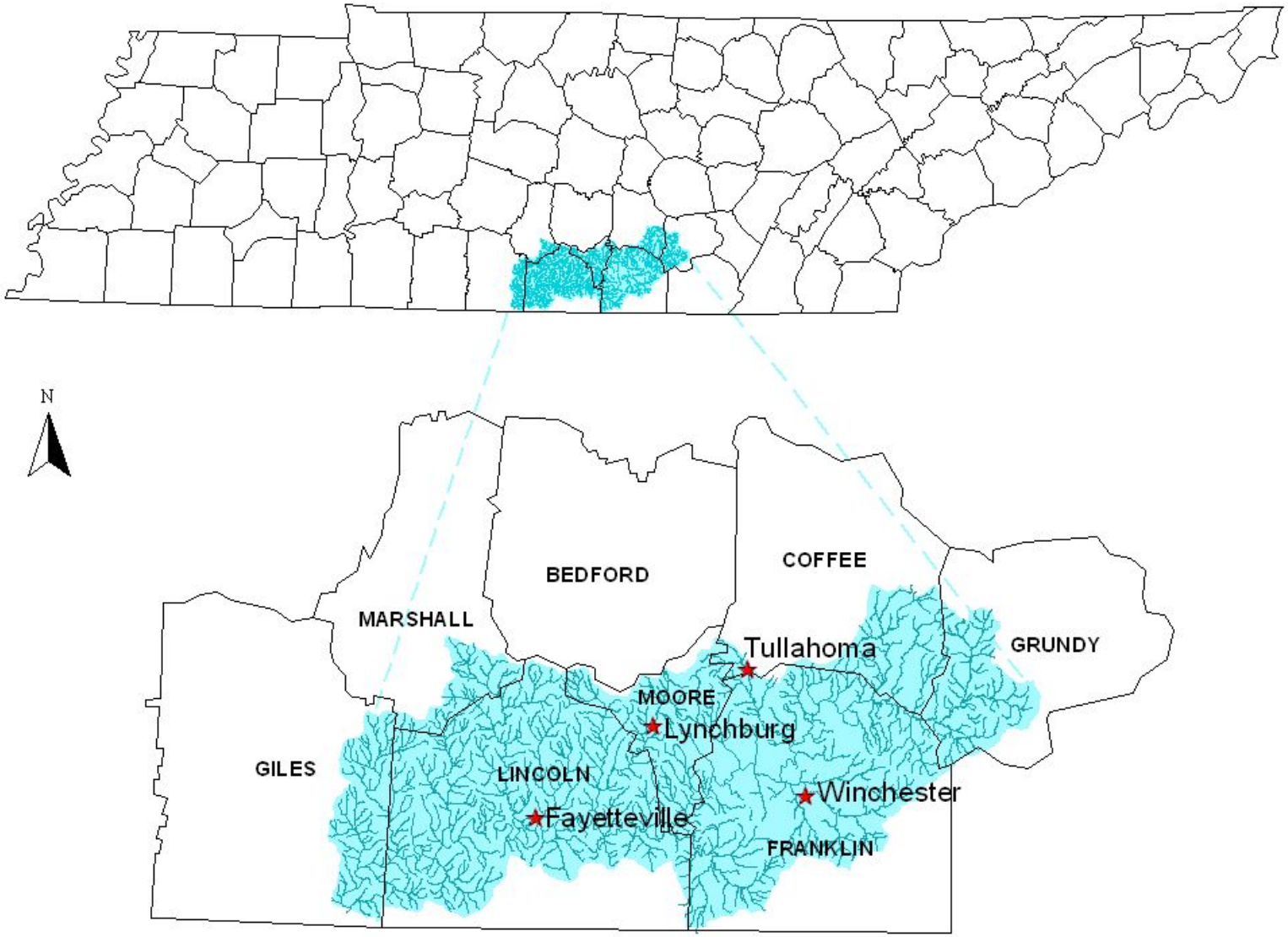


Figure 2 Level IV Ecoregions in the Upper Elk River Watershed

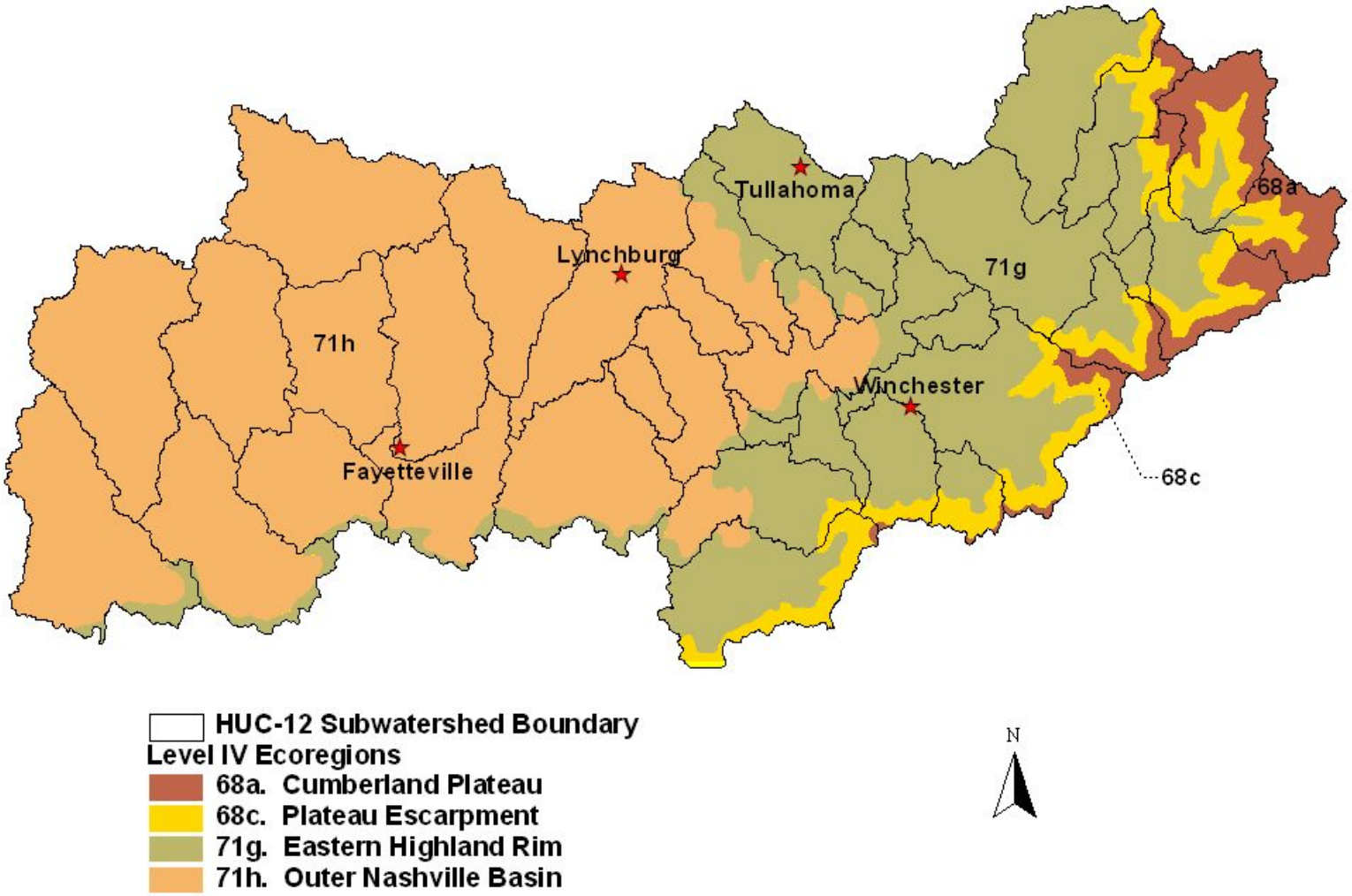


Figure 3 Land Use in the Upper Elk River Watershed

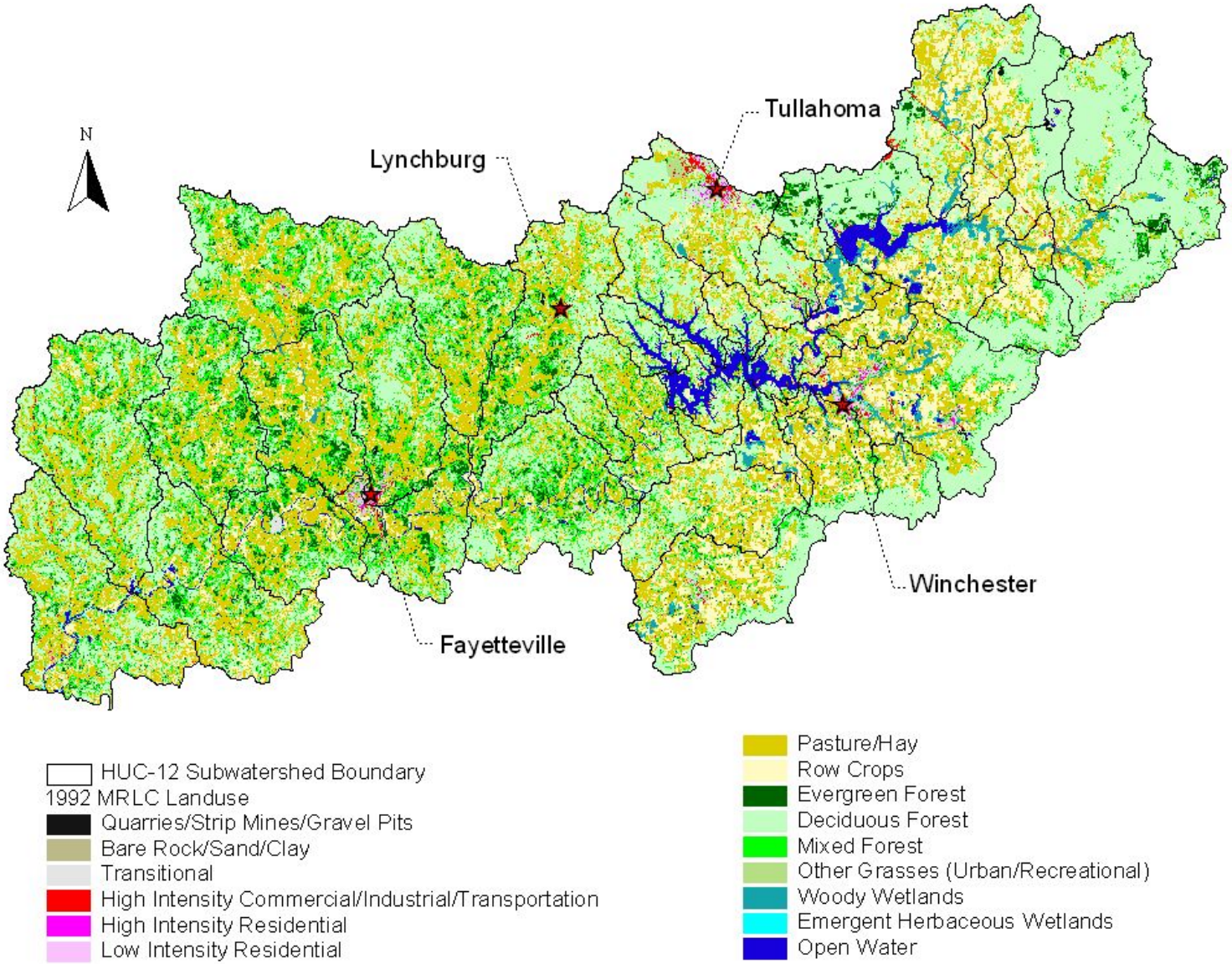


Table 1 Land Use Distribution – Upper Elk River Watershed

Landuse	Area		[% of watershed]
	[acres]	[mi^2]	
Deciduous Forest	301,543	471.2	36.7
Emergent Herbaceous Wetlands	865	1.4	0.1
Evergreen Forest	39,558	61.8	4.8
High Intensity Commercial/Industrial/Transportation	4,413	6.9	0.5
High Intensity Residential	933	1.5	0.1
Low Intensity Residential	5,788	9.0	0.7
Mixed Forest	104,842	163.8	12.8
Open Water	17,285	27.0	2.1
Other Grasses	3,990	6.2	0.5
Pasture/Hay	220,528	344.6	26.9
Quarries/Strip Mines/Gravel Pits	448	0.7	0.1
Row Crops	108,760	169.9	13.2
Transitional	1,530	2.4	0.2
Woody Wetlands	10,848	17.0	1.3
Total	**821,331**	**1,283.3**	**100.0**

Note: A spreadsheet was used for this calculation and values are approximate due to rounding.

3.0 PROBLEM DEFINITION

The designated use classifications for Woods Reservoir include domestic water supply, fish & aquatic life, industrial water supply, irrigation, livestock watering & wildlife, and recreation. The State of Tennessee's *2006 303(d) List* (TDEC, 2006) identified Woods Reservoir (TN06030003036_1000) in the Upper Elk River Watershed as not fully supporting designated use classifications due to elevated levels of polychlorinated biphenyls (PCBs) in fish tissue samples. Contaminated sediment has been identified as the source of pollutant causes associated with the impairment. The 2006 303(d) listing for Woods Reservoir is summarized in Table 2 and the waterbody is shown in Figure 4. Assessment information excerpted from the Assessment Database (ADB) is also listed in Table 2. ADB information may be accessed at:

http://gwidc.memphis.edu/website/dwpc/

Figure 4 Location of Woods Reservoir PCB Impairment (Documented on the *2006 303(d) List*)

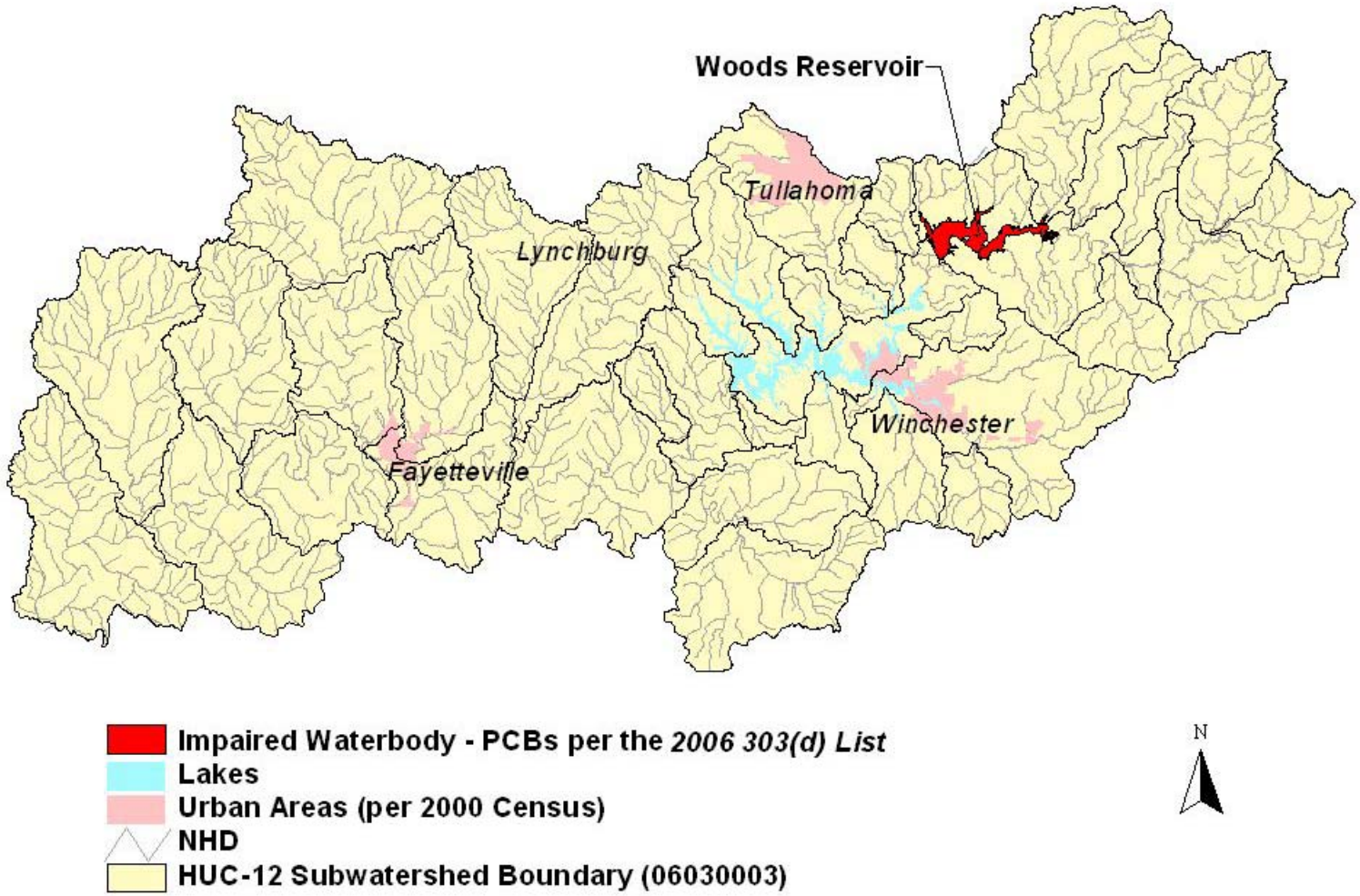


Table 2 *2006 303(d) List* - Stream Impairment Due to PCBs

Waterbody ID	Waterbody	Miles/ Acres	Cause (Pollutant)	Source (Pollutant)	Assessment Comments
TN06030003036_1000	Woods Reservoir (on the Elk River in Coffee County)	3908 ac	PCBs	Contaminated Sediment	Fish tissue monitoring by TDEC and AEDC. Fish tissue advisory in place--no consumption of catfish.

PCBs are a group of 209 distinct chlorinated biphenyl compounds. These 209 synthetic organic compounds vary not only in their physical and chemical properties, but also in toxicity (USEPA, 1999). PCBs exist as individual congeners or in the form of commercial mixtures known as Aroclors. Due to their chemical stability, polychlorinated biphenyls were used in a variety of commercial practices especially electrical and heat transfer processes.

PCBs were legally manufactured in the United States until the U.S. Environmental Protection Agency banned their production in 1979. Prior to this ban, PCBs were commonly used in transformers, capacitors, coatings, adhesives, and an assortment of other products. The manufacturing ban on PCBs did not require all PCB-containing materials to be removed from use. Therefore, some PCBs may still be utilized commercially. Before strict disposal regulations were established, large amounts of PCBs were discarded improperly. So, although the production of PCBs has ceased, these chemicals are widely distributed throughout the environment.

As stated in *Fact Sheet: Polychlorinated Biphenyls (PCBs) Update: Impact on Fish Advisories* (USEPA, 1999):

> Currently, the major source of PCBs is environmental reservoirs from past releases. PCBs have been detected in soil, surface water, air, sediment, plants, and animal tissue in all regions of the earth. PCBs are highly persistent in the environment with reported half-lives in soil and sediment ranging from months to years.

Once in the sediment, PCBs can enter the aquatic food chain. PCBs are fat-soluble chemicals with the potential to concentrate in fish tissue. As a result, humans may be exposed to PCBs through the consumption of contaminated foods, primarily contaminated fish. Studies have demonstrated adverse health effects resulting from PCB exposure. PCBs are classified as probable human carcinogens and among other things have been shown to be toxic to the immune system, the reproductive system, the nervous system and the endocrine system.

To protect fish consumers, the Tennessee Department of Environment and Conservation, Division of Water Pollution Control currently issues two types of fish consumption advisories. A “do not consume” advisory targets the general population and warns that no one should eat specific fish from a particular body of water. The “precautionary advisory” specifies that atypical consumers (those who are more sensitive to PCB consumption) should not consume the fish species named, and all other people should limit consumption to one meal per month (TDEC, 2004). A do not consume advisory for catfish was posted for Woods Reservoir.

4.0 TARGET IDENTIFICATION

This TMDL is being proposed for Woods Reservoir, which is impaired because PCBs in fish tissue samples were detected at levels that exceed the plausible-upper-limit carcinogenic risk (ref.: Appendix A). In order for a TMDL to be established, a numeric "target" protective of the uses of the water must be identified to serve as the basis for the TMDL. Numerical criteria, applicable to PCBs as toxic substances, have been established in *Rules of Tennessee Department of Environment and Conservation, Tennessee Water Quality Control Board, Division of Water Pollution Control, Chapter 1200-4-3 General Water Quality Criteria, January 2004* (TDEC, 2004) to preserve the various use classifications. The recreation designated use classification will provide the basis for this TMDL. While numerical criteria also exist under the fish & aquatic life designated use, TMDLs developed to protect recreation will protect all other use classifications for the identified waterbody from adverse alteration due to PCB loading. The Tennessee water quality criteria for individual PCB Aroclors and total PCBs are both 0.00064 µg/L under the recreation designated use classification. This value is the same for organism only and water & organism consumption. So, the 0.00064 µg/L water quality criterion will serve as the appropriate target for the TMDL.

5.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

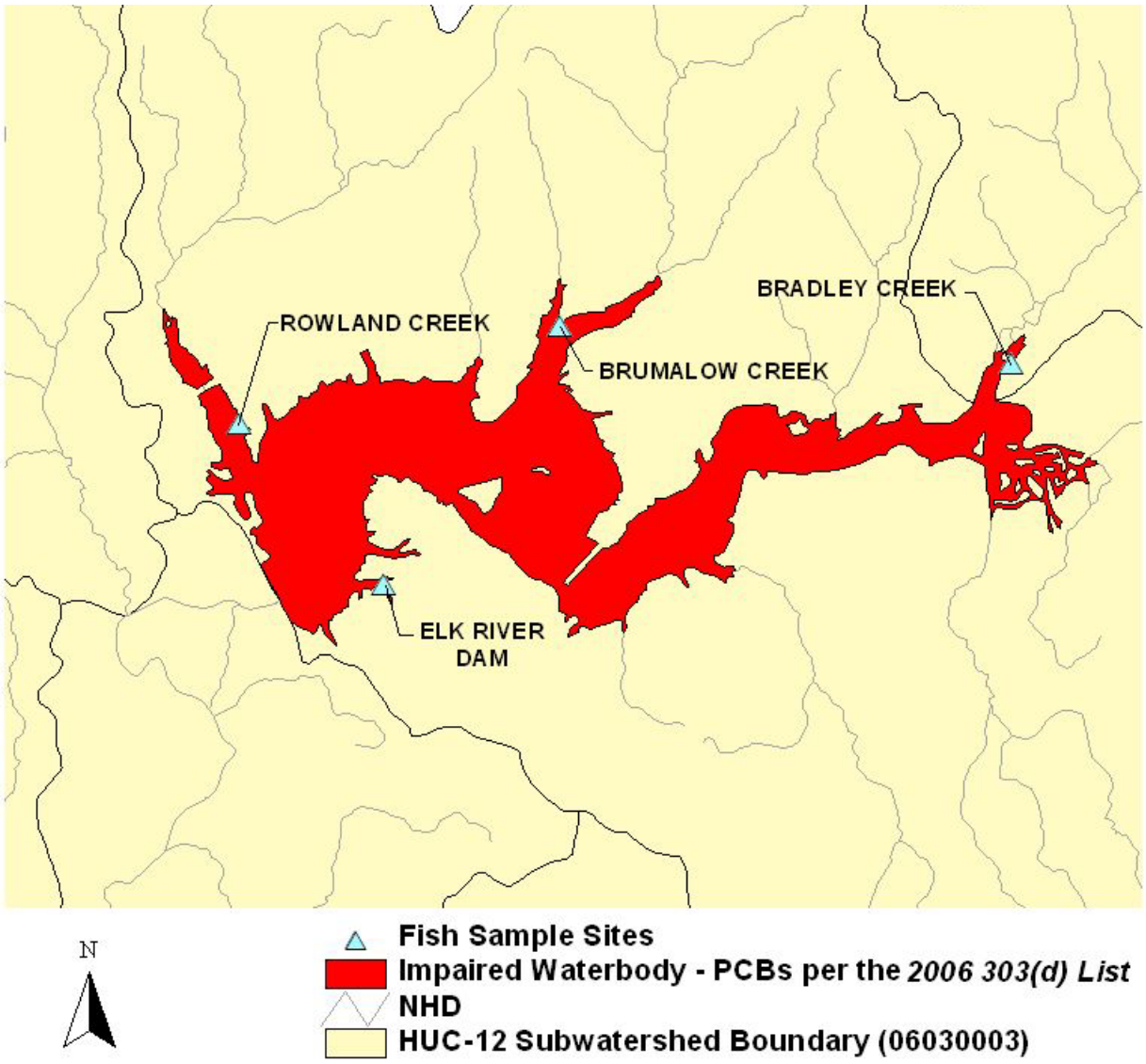
Fish tissue samples were collected from the sites shown in Figure 5. According to the methodology outlined in Section 7.1, the water column concentration and the existing load of PCBs in the water column were predicted from composite fish tissue data. The existing concentration of PCBs in the water column was estimated through the Bioconcentration Factor defined by the U.S. Environmental Protection Agency (ref.: Appendix A). This data is presented in Table 3. According to the fish species with the highest geometric mean of PCB concentrations, the existing water column concentration was estimated to be 0.01 µg/L, which is greater than the 0.00064 µg/L target value.

Table 3 Existing Concentration of PCBs in Woods Reservoir Predicted from Fish Tissue Samples

Fish Species	Sample Year	Sampling Site Location	Total PCBs in Fish Sample (ppm)	Calculated Water Column Concentration (µg/L)
Carp	2004	Rowland Creek	0.812	0.0260
		Bradley Creek	0.069	0.0022
		Brumalow Creek	0.255	0.0082
		Dam	0.661	0.0212
		Geomean	**0.312**	**0.0100**
Channel Catfish	2004	Rowland Creek	0.021	0.0007
		Bradley Creek	0.020	0.0006
		Brumalow Creek	0.236	0.0076
		Dam	0.116	0.0037
		Geomean	**0.058**	**0.0019**
LM Bass	2004	Rowland Creek	0.002	0.0001
		Dam	0.002	0.0001
		Geomean	**0.002**	**0.0001**

Note: Total PCBs equal the sum of all Aroclors detected at levels greater than sample quantification limits.

Figure 5 Sample Collection Sites in Woods Reservoir



6.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of individual sources, source categories, or source subcategories of PCBs in the watershed and the amount of pollutant loading contributed by each of these sources. According to the Clean Water Act, sources are broadly classified as either point or non-point sources. Under 40 CFR §122.2, a point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Regulated point sources include: 1) municipal and industrial wastewater treatment facilities (WWTFs); 2) storm water discharges associated with industrial activity (which includes construction activities); and 3) certain discharges from Municipal Separate Storm Sewer Systems (MS4s). For the purposes of this TMDL, all sources of PCB loading not regulated by NPDES are considered non-point sources.

6.1 Point Sources

There are numerous permitted dischargers in the Upper Elk River Watershed. However, there are currently no permitted point source dischargers with existing allocations for PCBs.

Past releases from Arnold Engineering Development Center (AEDC) have been identified as a probable source of historical PCB contamination in Woods Reservoir. AEDC is a federal facility located in Coffee and Franklin counties within the Upper Elk River Watershed on the land surrounding Woods Reservoir. PCBs were used at AEDC from approximately 1952 to 1990. This 32,000-acre Air Force testing site was proposed to the U.S. EPA National Priorities List (NPL) for Uncontrolled Hazardous Waste Sites in 1994 (USEPA, 1994a). The NPL site narrative states that PCBs were measured in soil samples near the site's Main Testing Area. According to the NPL description, it is suspected that "surface water from the Main Testing Area enters Woods Reservoir via several streams" (USEPA, 1994b). AEDC is an NPDES permitted facility (TN0003751), but they have been able to demonstrate "that PCBs are not present in current facility discharges" (TDEC, 2005).

6.2 Non-point Sources

Assessments have named contaminated sediment as the source of PCB impairment in Woods Reservoir. According to the U.S. Environmental Protection Agency, "Because PCBs have very low solubility in water and low volatility, most PCBs are contained in sediments that serve as environmental reservoirs from which PCBs may continue to be released over a long period of time. PCBs may be mobilized from sediments if disturbed (e.g., flooding, dredging)" (USEPA, 1999). Therefore, until site-specific data proves otherwise, this TMDL will consider contaminated sediment in the reservoir bed from past releases at AEDC as the primary source of PCB contamination in Woods Reservoir.

7.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load

Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure.

7.1 Analysis Methodology

TMDL analyses were performed at various sites to evaluate waterbodies identified as impaired on the *2006 303(d) List* due to elevated levels of PCBs in fish tissue samples. The TMDL for PCBs in the water column, and the corresponding required load reduction, were calculated according to the following procedure:

- Fish tissue samples were collected and analyzed as defined in *Woods Reservoir Fish Tissue PCB Monitoring Results* (AEDC, 2005).

- The geometric mean of the concentrations of PCBs in the fish tissue samples was calculated. If several species were analyzed from the same waterbody, the fish species with the highest geometric mean (ref.: Table 3) was used to estimate the concentration of PCBs in the water column:

$$C_{water} = \frac{C_{fish}}{BCF} \times 1{,}000$$

Where C_{fish}= Fish tissue concentration (mg/kg)
C_{water} = Water column concentration (µg/L)
BCF = Bioconcentration factor (31,200 L/kg)
1,000 = Conversion factor (µg/mg)

- Assuming uniform distribution, the existing total PCB load of the reservoir was computed as the product of the median winter pool volume and the calculated water column concentration (ref.: Section 5.0):

Existing Load = C_{water} x Winter Pool Volume x Unit Conversion Factor

- The maximum allowable amount of PCBs in the reservoir at any time was determined by the product of the water quality target concentration (ref.: Section 4.0) and the median winter pool volume:

Maximum Allowable Load = C_{target} x Winter Pool Volume x Unit Conversion Factor

- The TMDL was calculated by dividing the maximum allowable load of PCBs in the reservoir at any time by the hydraulic retention time (HRT).

$$TMDL = \frac{\text{Maximum Allowable Load}}{HRT}$$

- A percent reduction, corresponding to the TMDL, was computed based on the existing load and the maximum allowable load:

$$\%\ \text{Reduction} = \frac{\text{(Existing Load) - (Maximum Allowable Load)}}{\text{(Existing Load)}} \times 100\%$$

- A 20% explicit margin of safety was incorporated into the TMDL.

- Waste load and load allocations were calculated using the TMDL value.

7.2 Margin of Safety

There are two methods for incorporating a Margin of Safety (MOS) into the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In this TMDL, a 20% explicit margin of safety was utilized to account for uncertainties.

7.3 Seasonal Variation

There are no known sources of additional PCB loading to Woods Reservoir, which indicates that the mass of PCBs contained in the reservoir bed can be assumed to be relatively constant over short periods of time. So the concentration of PCBs should be inversely proportional to the volume of water in the reservoir. Determination of PCB loads using the median winter pool volume (when reservoir levels generally are lowest) accounts for periods when the PCB concentrations would theoretically be the greatest. Therefore, the TMDL will provide year-round protection of water quality standards.

7.4 TMDL for the Impaired Waterbody

For Woods Reservoir the median winter pool volume between 1999 and 2006 was 3,296,014,534 ft^3. The average hydraulic retention time was calculated to be 319 days (1999 – 2006). The TMDL was derived according to the methodology described in Section 7.1.

Maximum Allowable Load = 0.00064 µg/L x 3,296,014,534 ft^3 x 28.32 L/ft^3 x 10^{-6} g/µg = 59.74 g

TMDL = 59.74g / 319 days = 0.19 g/day

Using the estimated water column concentration, 0.01 µg/L (ref.: Section 5.0), the existing load was calculated:

$$\text{Existing Load} = 0.01\ \mu g/L \times 3{,}296{,}014{,}534\ ft^3 \times 28.32\ L/ft^3 \times 10^{-6}\ g/\mu g = 933.43\ g$$

The percent reduction corresponding to the TMDL was computed from the existing load and maximum allowable load:

$$\%\ \text{Reduction} = \frac{(933.43\ g) - (59.74\ g)}{(933.43\ g)} \times 100\% = 93.6\%$$

The TMDL represents the maximum allowable daily loading of PCBs. Furthermore, this value assumes that the mass of PCBs will be uniformly distributed throughout the waterbody. Such conditions may or may not exist, and in either case the localized concentration of PCBs in Woods Reservoir should not exceed 0.00064 µg/L. The TMDL and corresponding percent reduction are summarized in Table 4.

7.5 Development of Waste Load Allocations and Load Allocations

7.5.1 Waste Load Allocations

There are currently no permitted point source dischargers with existing allocations for PCBs. Zero waste load allocations are being provided.

7.5.2 Load Allocations

The load allocation requires the contribution from non-point sources to be less than or equal to the TMDL target value. In the absence of point sources,

$$LA = TMDL - MOS$$

Incorporating the 20% MOS into the TMDL restricts the load of PCBs in Woods Reservoir to 0.15 g/day. The allocations for Woods Reservoir are also provided in Table 4.

8.0 IMPLEMENTATION PLAN

8.1 Point Sources

There are currently no NPDES permitted facilities with an existing allocation to discharge PCBs to Woods Reservoir. Arnold Engineering Development Center (AEDC), however, is suspected to be a source of past PCB contamination. Therefore, according to the provisions stated in their NPDES permit (TN0003751), AEDC is required to conduct biennial fish tissue studies in order to "determine the existence and extent of chemical contaminants in the form of polychlorinated biphenyls (PCBs)" (TDEC, 2005). PCBs are not believed to be present in current discharges, so waste load allocations are not being provided. Waste load allocations can be determined, if needed, once the fish tissue concentrations indicate that the reservoir is no longer impaired for elevated levels of PCBs.

Table 4 TMDL and Allocations for Woods Reservoir (TN06030003036_1000)

Waterbody ID	Impaired Waterbody	Pollutant	TMDL	WLA	LA	MOS	*Required Load Reduction**
			[g/day]	[g/day]	[g/day]	[g/day]	*[%]*
TN06030003036_1000	Woods Reservoir	PCBs	0.19	N/A	0.15	0.04	*93.6*

*Note: Load reduction required to achieve TMDL.

8.2 Non-point Sources

The Tennessee Department of Environment & Conservation (TDEC) has no direct regulatory authority over most non-point source discharges. Voluntary, incentive-based mechanisms will be used to implement non-point source management measures in order to assure that measurable reductions in pollutant loadings can be achieved for the impaired waterbody.

Contaminated sediment was listed as the likely source for PCB contamination in Woods Reservoir. There are generally two options to prevent PCBs contained in the sediment from being released to the reservoir: 1) avoid disturbing the sediment or 2) remediate contaminated sites. If the sediment remains undisturbed, the PCBs should degrade over time. On the other hand, if the sediment must be disturbed, remediation efforts will be necessary to control the load of PCBs in the reservoir so that the water quality criteria are not exceeded. Strategies to identify sites with elevated levels of PCBs may be helpful for implementing controls to prevent these contaminants from being released into the reservoir. As fewer PCBs become biologically available the concentrations of PCBs measured in fish tissue samples should theoretically decline. Due to the chemical stability of PCBs, however, continued fish tissue monitoring is advised to ensure that contamination decreases as time passes.

8.3 Evaluation of TMDL Effectiveness

The effectiveness of the TMDL will be assessed within the context of the State of Tennessee's rotating Watershed Approach. The Watershed Approach is based on a five-year cycle and encompasses planning, monitoring, assessment, TMDLs, WLAs/LAs, and permit issuance (ref.: http://www.state.tn.us/environment/wpc/watershed/). Watershed monitoring and assessment activities will provide information by which the effectiveness of PCB load allocations can be evaluated. Continued fish tissue sampling will be necessary to monitor the efficacy of the proposed TMDL. The TMDL will be reevaluated during subsequent watershed cycles and revised as required to assure attainment of applicable water quality standards.

9.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed PCB TMDL for Woods Reservoir was placed on Public Notice for a 35-day period and comments were solicited. Steps taken in this regard included:

1) Notice of the proposed TMDL was posted on the Tennessee Department of Environment and Conservation website. The notice invited public and stakeholder comments and provided a link to a downloadable version of the TMDL document.

2) Notice of the availability of the proposed TMDL (similar to the website announcement) was included in one of the NPDES permit Public Notice mailings, which were sent to interested persons or groups who have requested this information.

3) A letter was sent to point source facilities in the Upper Elk River Watershed who discharge to Woods Reservoir and/or its tributaries. The letter advised them of the proposed PCB TMDL, stated the document's availability on the TDEC website, and invited comments. Letters were sent to the following facilities:

TN0003751	Arnold Engineering Development Center
TN0067202	University of Tennessee Space Institute

4) A letter was sent to identified water quality partners in the Upper Elk River Watershed advising them of the proposed PCB TMDL, stating the document's availability on the TDEC website, and inviting comments. These partners included:

Natural Resources Conservation Service
Tennessee Department of Agriculture
Tennessee Valley Authority
Tims Ford Council
United States Fish and Wildlife Service
United States Geological Survey

5) A letter was sent to the following MS4s advising them of the proposed PCB TMDL, stating the document's availability on the TDEC website, and inviting comments:

TNS077631	Tullahoma
TNS077585	Tennessee Department of Transportation

10.0 FURTHER INFORMATION

Further information concerning Tennessee's TMDL program can be found on the Internet at the Tennessee Department of Environment and Conservation website:

http://www.state.tn.us/environment/wpc/tmdl/

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Pollution Control staff:

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11.0 REFERENCES

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APPENDIX A

Development of Water Quality Criteria for PCBs

CARCINOGENIC RISK LEVEL

According to Section 304(a) of the Clean Water Act, the U.S. Environmental Protection Agency presented three separate criteria for carcinogens at risk levels corresponding to 10^{-7}, 10^{-6}, and 10^{-5} in the 1980 *Ambient Water Quality Criteria for Polychlorinated Biphenyls* (USEPA, 1980). Within select sections of the 2000 Human Health Methodology (USEPA, 2000a), the U.S. EPA states:

> Both 10^{-6} and 10^{-5} are appropriate targets for health protection of the general population and that highly exposed populations should not exceed a 10^{-4} risk level. The incremental cancer risk levels are *relative*, meaning that any given criterion associated with a particular cancer risk level is also associated with specific exposure parameter assumptions (*i.e.,* intake rates, body weights). EPA recommends adoption of water quality standards that include water quality criteria based on either the 10^{-5} or 10^{-6} risk level if the State or authorized Tribe has identified the most highly exposed subpopulation, has demonstrated that the chosen risk level is adequately protective of the most highly exposed subpopulation, and has completed all necessary public participation. States and authorized Tribes also have flexibility in how they demonstrate this protectiveness and obtain such information. A State or authorized Tribe may use existing information as well as collect new information in making its determination as to an appropriate level of protection.

The Tennessee Department of Environment and Conservation, Division of Water Pollution Control designates a 10^{-5} risk level for all carcinogenic pollutants. A public fishing advisory will be considered when the calculated risk of additional cancers exceeds 10^{-4} for typical consumers or 10^{-5} for atypical consumers (TDEC, 2004).

Human Health Criteria for Carcinogenic Pollutants

U.S. Environmental Protection Agency has developed equations for deriving human health criteria for carcinogenic pollutants. As published in *Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance – Revision of Polychlorinated Biphenyls (PCBs) Criteria; Final Rule* (USEPA, 1999a), the human health criterion for organism and water consumption is as follows:

$$HHC = \frac{R \times W}{q \times [WC + (FC \times BCF)]} \times 1{,}000$$

Similarly, the human health criterion for organism only consumption is listed below:

$$HHC = \frac{R \times W}{q \times FC \times BCF} \times 1{,}000$$

Where HHC = Human health criterion (µg/L)
R = Risk Level
W = Human Body Weight (kg)
q = Cancer Slope Factor $(mg/kg \cdot day)^{-1}$
WC = Water Consumption (L/day, applicable to drinking water supply)
FC = Fish Consumption (kg/day)
BCF = Bioconcentration Factor (L/kg)
1,000 = Conversion Factor (µg/mg)

State Water Quality Criteria for PCBs

National recommended water quality criteria are published pursuant to Section 304(a) of the Clean Water Act. The national criteria provide guidance for states to use when adopting water quality standards. EPA's current national recommended water quality criteria for PCBs equal 0.000064 µg/L for both organism only criteria and water & organism criteria. These values were derived using the above equations for Human Health Criteria when, as listed in the 1999 PCB Criteria (USEPA, 1999a) and updated in the 2000 Human Health Methodology revision (USEPA, 2000a):

$R = 1x10^{-6}$
W = 70 kg
$q = 2\ (mg/kg \cdot day)^{-1}$
WC = 2 L/day
FC = 0.0175 kg/day
BCF = 31,200 L/kg

Because the State of Tennessee sets the plausible-upper-limit risk of cancer associated with PCBs at the 10^{-5} risk level, the corresponding state water criteria are 0.00064 µg/L (http://www.epa.gov/waterscience/criteria/wqcriteria.html). For the purposes of this TMDL, the state water quality criteria for PCBs were used to determine the target value.

APPENDIX B

Public Notice Announcement

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL) FOR POLYCHLORINATED BIPHENYLS FOR WOODS RESERVOIR IN THE UPPER ELK RIVER WATERSHED (HUC 06030003), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed Total Maximum Daily Load (TMDL) for polychlorinated biphenyls (PCBs) for Woods Reservoir in the Upper Elk River Watershed, located in southern middle Tennessee. Section 303(d) of the Clean Water Act requires states to develop TMDLs for waters on their impaired waters list. TMDLs must determine the allowable pollutant load that the water can assimilate, allocate that load among the various point and nonpoint sources, include a margin of safety, and address seasonality.

Woods Reservoir was identified on Tennessee's Final 2006 303(d) list as not supporting designated use classifications due to elevated levels of polychlorinated biphenyls (PCBs) in fish tissue samples. Contaminated sediment is the source of pollutant cause associated with the impairment. Using a mass-balance approach, the TMDL utilizes Tennessee's general water quality criteria, fish tissue sampling data collected from Woods Reservoir, Bioconcentration Factors defined by the U.S. Environmental Protection Agency, and an appropriate Margin of Safety (MOS) to establish a PCB loading level which will result in lower fish tissue concentrations and the attainment of water quality standards.

The proposed PCB TMDL may be downloaded from the Department of Environment and Conservation website:

http://www.state.tn.us/environment/wpc/tmdl/

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Pollution Control staff:

Vicki S. Steed, P.E., Watershed Management Section
Telephone: 615-532-0707

Bruce R. Evans, P.E., Watershed Management Section
Telephone: 615-532-0668

Sherry H. Wang, Ph.D., Watershed Management Section
Telephone: 615-532-0656

Persons wishing to comment on the proposed TMDL are invited to submit their comments in writing no later than October 15, 2007 to:

Division of Water Pollution Control
Watershed Management Section
7th Floor, L & C Annex
401 Church Street
Nashville, TN 37243-1534

All comments received prior to that date will be considered when revising the TMDL for final submittal to the U.S. Environmental Protection Agency.

The TMDL and supporting information are on file at the Division of Water Pollution Control, 6th Floor, L & C Annex, 401 Church Street, Nashville, Tennessee. They may be inspected during normal office hours. Copies of the information on file are available on request.